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Original Research

Effect of anesthesia type (local or general) on neurocognitive functions in carotid endarterectomy

The effect of anesthesia type on neurocognitive functions

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Abstract

Aim: Neurocognitive disorders and major neurological complications can develop after carotid endarterectomy. The aim our was to investigate the effect of local or general anesthesia during carotid endarterectomy on these neurocognitive functions via objective tests.

Material and Methods: The study included 30 patients who underwent carotid endarterectomy under different types of anesthesia (general anesthesia in 16 patients or local anesthesia in 14 patients) between June 2017 and August 2019. Postoperative neurocognitive functions of the patients were compared using tests to quantitatively evaluate their cognitive performance (Standardized Mini-Mental Test and Clock Drawing Test).

Results: Twenty-one patients were male and nine were female. There was no serious coronary lesion, except for carotid artery stenosis. None of the patients developed major complications such as stroke or transient ischemic attack. Length of stay in the intensive care unit and hospital was shorter in the local anesthesia group (p=0.005 and p=0.001). Although the preoperative Standardized Mini-Mental Test and Clock Drawing Test results of the groups were similar (p=0.765 and p=0.999), there was a significant difference in favor of the local anesthesia group in both tests in the pre-discharge period (p=0.001).

Discussion: Although there is no significant difference in terms of major neurological complications, local anesthesia applications show positive results in terms of neurocognitive functions. We believe that the use of local anesthesia in carotid endarterectomy operations, to the extent allowed by other clinical features of the patient, is important for neurocognitive functions, despite surgical difficulties.

Keywords

Carotid Endarterectomy; Local Anesthesia; General Anesthesia; Neurocognitive Functions

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Introduction

Atherosclerotic cardiovascular diseases (CVDs) are one of the major causes of mortality throughout the world. Among these diseases, carotid artery occlusion (CAO) has a prominent place. Increased intima-media thickness in the carotid arteries and luminal stenosis due to atherosclerosis cause approximately 20% of ischemic stroke events [1,2]. The first attempt at carotid endarterectomy (CEA) was performed in 1954 to eliminate this vascular problem, and it became more popular in the following years. It is considered as a treatment method that significantly reduces the risk of cerebrovascular events in patients with stenosis of 60% or greater [4-6]. Despite the development of techniques and intraoperative monitoring methods, major complications such as stroke, myocardial infarction, and mortality are commonly observed [7]. Although CEA is accepted as the gold standard for treatment of patients with severe carotid artery stenosis, there are still controversies about the anesthesia method to be applied during the operation. Both methods have their advantages and disadvantages. General anesthesia is accepted as the most comfortable method for the surgeon. During this method, the patient can be ventilated more safely and medical interventions made by the anesthetist for cerebral protection are easier. However, the assessment of cerebral functions is highly restricted. In local anesthesia, it is easier to follow the neurological functions, but the need for patient compliance comes to the fore. The disadvantages of this method include the patient's agitation in the failure of local anesthesia and the need to urgently return to general anesthesia in the presence of respiratory problems [8].

The incidence of complications including stroke, myocardial infarction, and mortality in CEA is less than 7% [9,10]. Although they are rarer than others, hemorrhages due to the opening during the early period of arteriotomy, and pseudoaneurysms from the arteriotomy site in the late period may occur [11]. Although CEA aims to reduce possible neurological complications, minor neurological complications such as a decline in neurocognitive functions and transient ischemic attack, major complications such as stroke, may develop depending on the surgery performed [12]. Intraoperative hemodynamic instability, disruptions in cerebral blood flow, cerebral embolization, and undesirable side effects of anesthetic agents used are involved in the development of these complications [13,14]. Although major neurological complications can be identified using imaging methods and classical physical examinations, several neurological problems that may arise due to impaired cerebral blood flow or microembolism cannot be identified with radiological methods. Among these complications, a decline in neurocognitive functions is the prominent one. Its incidence reaches 25% regardless of the type of anesthesia. Although the type of anesthesia used has been comprehensively compared in the General Anesthesia Versus Local Anesthesia (GALA) trial, discussions regarding the type of anesthesia are still ongoing.

This study aimed to compare the effect of anesthesia types used in CEA operations on neurocognitive functions in the early postoperative period using objective tests that were not used before in this regard.

Material and Methods

Patient selection, grouping and study design

The study included patients who were hospitalized for operation (60% and above) due to severe isolated carotid artery stenosis. The patients were divided into two groups in turn. The order of patients who had special requests for the type of anesthesia and who had contraindications for the type of anesthesia was changed. Patients with a special demand regarding the type of anesthesia were included in the group of their choice. The patients were divided into two groups namely Group 1 consisting of 16 patients (11 males, 5 females) and Group 2 consisting of 14 patients (10 males, 4 females). Group 1 was operated under general anesthesia and Group 2 was operated under local anesthesia. The standardized Mini-Mental Test (SMMT) and Clock Drawing Tests (CDT) were applied the day before the operation, the first postoperative day, and the day before discharge to measure neurocognitive functions of the patients. The same test was performed three times in total for each patient. Demographic data, intraoperative monitoring, and postoperative follow-up parameters of the patients were recorded. All patients were informed about the study and their written consent was obtained. This study was approved by the local ethics committee (Atatürk University Faculty of Medicine Clinical Researches of Ethical Committee. Ethical Approval Number: B.30.2.ATA.0.01.00/283)

Anesthesia applications and surgical procedures

General anesthesia

On the morning of the surgery day, the patient was admitted to the operating room and standard American Society of Anesthesiologists monitoring was performed. All patients underwent standardized preoperative assessment, sedation, and anesthetic management. Anesthesia was induced with 0.5 mg/kg midazolam, 5 mg/kg thiopental sodium, 0.6 mg/kg rocuronium was administered. Remifentanil was administered as a 0.3 mcg/kg bolus just before induction, followed by an infusion of 0.1-0.25 mcg/kg/min throughout the surgery. Anesthesia was maintained with %2 sevoflurane and intermittent doses of rocuronium. Remifentanil infusion dose adjustment was left under the supervision of the anesthesiologist.

Local anesthesia

Patients were taken to the regional anesthesia room 30 minutes before the surgery. Vascular access was established with routine monitoring. In the supine position, the patient's head was turned towards the side opposite to the side planned for surgery. The 18-Hz Linear ultrasound transducer (Esaote MyLab 30 Genova-Italia) was placed transversely in the middle of the sternocleidomastoid muscle (SCM). Advancing towards the posterior, the endpoint of the muscle was displayed on the screen. From this region, a 22-gauge 5-mm sonovisible peripheral nerve block needle (B. Braun Melsungen AG, Melsungen, Germany) was inserted towards the bottom of SCM through an in-plane technique. The area was confirmed by 1-2 mL saline injection. A total of 15 mL of local anesthetic mixture containing 0.25% bupivacaine and 1% lidocaine was used; 10 mL was injected between SCM and the prevertebral fascia and 5 mL was injected along the carotid sheath. All procedures were performed in accordance with the rules of aseptic and antiseptic surgery. Before the start of the surgery, it was confirmed that all patients were completely anesthetized with a superficial cervical plexus block and then, the surgery was initiated.

Regardless of the type of anesthesia, heparinization was performed after surgical exploration in all patients. After the clamp was placed, arteriotomy was performed and atherosclerotic plaques were cleaned. Vascular forceps were used to perform the endarterectomy and the arteriotomy area was closed with a pericardial patch. No shunt was used in any of the patients, since there was no severe stenosis in the other carotid arteries. General anesthesia had to be performed due to the severe agitation affecting the operation in one of the patients undergoing local anesthesia. This patient was excluded from the study. Patients with carotid artery stenosis accompanied by coronary artery stenosis, and those who underwent simultaneous coronary artery bypass operation were also excluded from the study.

The Clock Drawing Test

Patients are drawn to one hour, asked to put the numbers in the appropriate positions and mark the time reported to the patient. Structural praxis and comprehension and planning ability are tested with this test. The total score is 6. Scores below 4 indicate cognitive dysfunction. Scoring is done as follows:

• The position of the number twelve is correct: 3 points,

• All twelve numbers were written down: 1 point,

• The hour and minute hands were drawn: 1 point,

• The time announced to the patient was marked correctly: 1 point.

Advantages of the clock drawing test:

- A short test,
- It requires a shorter time to apply
- Includes the fact that it has a high negative predictive value.

However, test scoring is subjective, and there is a high level of false negativity as the disadvantages of the results.

Standardized Mini Mental Test (SMMT)

The standardized mini mental test is used for the quantification of cognitive performance. Although it has limited specificity for differentiating clinical syndromes, it can be used for a global assessment of cognition as a brief, convenient, and standardized method. It comprises eleven items categorized under five major themes, which are orientation, registration memory, attention and calculation, recall, and language. The highest total test score is 30.

Statistical Analysis

Statistical analyses were performed using the Number Cruncher Statistical System (NCSS) 2007 (Kaysville, Utah, USA). Descriptive statistics (mean, standard deviation, median, frequency, percentage, minimum, and maximum) were used to evaluate the study data. The distribution of the data was evaluated using the Shapiro-Wilk Test. The Mann-Whitney-U test was used to compare quantitative data between two groups that did not show a normal distribution. The Chi-Square test was used in qualitative data. A p- level of <0.01 and 0.05 was considered statistically significant.

Results

There was no difference between the two groups in terms of demographic characteristics (e.g. age, sex, etc.) (Table 1). Operation time was significantly longer in patients undergoing general anesthesia compared to those receiving local anesthesia (p=0.835). The clamping time was similar between both groups (Table 2). None of the patients had serious neurological complications. Although facial paralysis occurred in two patients in Group 1 and one patient in Group 2 in the early postoperative period, it disappeared in the first-month control. Moderate hoarseness occurred in one of the patients in Group 2. An improvement was achieved in these complications within 15 days with steroid treatment. Furthermore, none of our patients developed myocardial complications in the preoperative and postoperative periods. One patient in the general anesthesia group was re-operated for hematoma developed at the postoperative fourth hour, and bleeding revision was performed under local anesthesia. All patients in the group operated under general anesthesia were extubated in the intensive care unit (ICU).

Table 1. Demographic data

	Group 1 (n: 16)	Group 2 (n: 14)	p value
Age (year)	63,19±6,21	60,86±7,98	0,377
Gender (male/female)	11/5	10/4	0,596
Hypertension (n/%)	10 (%62,5	8 (%57,1)	0,529
Diabetes mellitus (n/%)	5 (%31,3)	3 (%21,4)	0,426
COPD (n/%)	3 (%18,8)	3 (%21,4)	0,605
Hyperlipidemia (n/%)	8 (%50)	9 (%64,3)	0,431
Cigarette (n/%)	9 (%56,3)	5 (%35,7)	0,225
BMI (kg/m^2)	26,45±1,69	25,26±2,25	0,109
EF (%)	58,75±7,64	60,36±6,34	0,521
Degree of stenosis (%)	77,5±10,8	82,14±8,71	0,214

COPD: Chronic Obstructive Pulmonary Disease, BMI: Body Mass Index, EF: Ejection Fraction

Table 2. Intraoperative and postoperative data

	Group 1 (n: 16)	Group 2 (n: 14)	p value
Clamp time (min)	30,25±4,22	33,5±4,65	0,094
Operation time (min)	87,69±13,89	88,79±12,66	0,835
Intensive Care Unit stay (hours)	34,75±6,36	27,71±5,7	0,005*
Hospital stay (hours)	103±16,64	80,29±7,92	0,001*

* Mann- Whitney U Test

Table 3. Clock Drawing Test and SMMT data

	Group 1 (n: 16)	Group 2 (n: 14)	p value
SMMT			
Pre-op	27,94±1,29	28,07±1,33	0,765
Post-op 1st day	23,69±1,74	27,43±1,02	0,001
Before discharge	23,94±1,34	27,86±0,86	0,001
CDT			
Pre-op	5,5±0,52	5,5±0,52	0,999
Post-op 1st day	4,38±0,62	5,5±0,52	0,001
Before discharge	5,25±0,45	5,43±0,51	0,001

SMMT: Standard Mini Mental Test
CDT: Clock Drawing Test

Although there were no differences between the two groups in the preoperative period (p=0.999) in terms of the clock drawing test, which was one of the tests performed to evaluate neurocognitive functions, a significant decrease was detected on the first postoperative day in Group 1 (p=0.001). The tests performed on the day before discharge similarly showed a significant decrease in Group 1 (p=0.001). In the evaluation made within the groups, a significant decline was observed in both the postoperative first day and pre-discharge values in Group 1. This decline was higher on the postoperative first day than on the day before discharge (p=0.001). Although there was also a decrease in these values in Group 2, these changes were not statistically significant (p=0.882).

As in the other test, there was no difference in terms of the preoperative SMMT values (p=0765). Unlike the other test, both measurements made on the postoperative first day and the day before discharge were significantly higher in the local anesthesia group in this test (p=0.001) (Table 3). The intragroup evaluation showed that the results of the postoperative first day and pre-discharge period in Group 1 were significantly lower than the preoperative period (p=0.001). Although there was a decrease in Group 2, it was not statistically significant (p=0.094).

There was no statistically significant difference in the length of stay in ICU and the discharge times, although the length of stay in the ICU was longer in Group 1 (p=0.215). The length of hospital stay was found to be similar between the groups. The length of hospital stay was significantly lower in the local anesthesia group than in the other group (p=0.001).

Discussion

The CEA is a highly effective method to reduce the frequency of major cerebrovascular events in patients with severe carotid stenosis. Numerous studies have revealed sufficient evidence in this regard [15,16]. It has an important place in vascular surgery operations all over the world.

This surgical method has been successfully performed under both general anesthesia and local anesthesia for many years. Although discussions about the choice of anesthesia type have decreased slightly with studies, particularly the comprehensive GALA trial [17] conducted in 2009 and meta-analysis studies by Vaniyapong et al. [18], the issues not addressed in these studies and some recent studies have shown that the discussions on this issue are ongoing. There is a limited number of studies on the evaluation of neurocognitive functions for the selection of anesthesia type. Most of these studies were based on laboratory tests that can be used to evaluate these functions. In this prospective controlled randomized trial, it has been tried to contribute to the previous studies on this subject by using some tests accepted as objective measurement methods.

Similar demographic characteristics and preoperative neurocognitive function test results, obtained despite the hospitalization of the patients included in the study with a diagnosis of isolated carotid stenosis and performing operation under different anesthesia methods repeatedly have contributed to the interpretation of the study results in terms of the type of anesthesia.

The effects of the anesthesia type on neurocognitive functions after surgery are not fully clarified. Decreases in cerebral blood flow and micro-level embolism are the underlying reasons for these changes after CEA operation [19]. The relationship of these reasons with the type of anesthesia has not been fully established yet. This study investigates the results, not the formation mechanism of the event. In operations performed under general anesthesia other than CEA, no deterioration in neurocognitive functions is observed in postoperative tests. This loss of function in CEA operations has been attributed to hypoperfusion caused by clamping [20]. There are studies reporting that perfusion disorder, which may occur due to clamping, can be reduced by using shunts [21]. Since no shunt was used in any patient in our study, no difference was observed between the groups in this respect. There are also studies suggesting that the decline in neurocognitive dysfunction after CEA is due to the hypoperfusion occurring during the operation, regardless of the type of anesthesia. In this study, Heyer et al. suggested that imaging methods cannot reveal any differences [22]. However, the underlying basis of this study was slightly weakened since the impairments in neurocognitive functions cannot be detected radiologically in general. In the present study, neurocognitive functions of patients operated under two types of anesthesia were assessed using tests, tests that were recognized as useful, rather than imaging methods.

The standard clock drawing test, which was one of the tests used in this study, did not differ between the groups in the preoperative period. The absence of a significant difference between the groups made it easier to perform the analyses at the beginning. Although these test results were better in the local anesthesia group on the postoperative first day, these values decreased on the day before discharge. This indicates that the loss of function that occurred in the early operational period decreased in the following days. In this respect, our study is similar to the study conducted by Weber et al. [14] in 2009. However, the results obtained from SMMT, which was one of the other tests performed to evaluate neurocognitive functions, were similar between the groups in the preoperative period, whereas the local anesthesia group was found to have better results on the postoperative first day and day before the discharge.

Antiplatelet therapy started before operation is also effective in determining the type of anesthesia to be used in CEA operations. In general, it is recommended that patients using these drugs should be operated without stopping the ongoing therapy and general anesthesia should be preferred. Although this leaves anesthesiologists in doubt about bleeding complications during local anesthesia, local anesthesia is successfully performed under ultrasound guidance for these patients in our hospital. Some studies on this subject are also suggestive in this regard [23].

The surgeon's preference, as well as all of these factors, are very important in determining the type of anesthesia. With the exception of surgical requirements, most of the surgeons prefer general anesthesia as it is more comfortable [24]. Although there are justified reasons such as difficulties in blood pressure control and agitation, local anesthesia is also highly preferred because of its advantages such as postoperative discharge times, costs, and differences in neurocognitive functions. In the present study, the neurocognitive functions of the patients were not evaluated as a priority for being discharged from the ICU. Therefore, no significant difference was observed between the groups, although the length of stay in the ICU was shorter in the local anesthesia group. However, there was a difference in favor of the local anesthesia group in terms of the length of hospital stay. We believe that changes in neurocognitive functions and readiness for discharge within a shorter period of time in this patient group have been effective in the formation of this difference. Although there has been no significant difference between the groups in terms of major neurological complications in the present study, local anesthesia seems to be more advantageous due to its positive effects on neurocognitive functions. Local anesthesia can be successfully applied in patient groups in whom general anesthesia may be associated with a high risk (e.g. chronic obstructive pulmonary disease). Since the number of patients was not high in the present study, the number of patients whose anesthesia type was selected according to this factor was very low.

Study limitations

Since the incidence of isolated carotid artery stenosis in the community is not very high, the number of patients included during the study remained low.

In our study, radiological imaging was not performed to the patients in the post-operative period. The comparison was made only with objective tests.

Conclusion

There is no significant difference between the types of anesthesia used for CEA operations in terms of major complications and mortality rates. However, each anesthesia type has advantages and disadvantages that come to the forefront. The results obtained from this study, in which objective tests that have not been used before in this regard, except for biochemical parameters or imaging methods, have been used, suggests that neurocognitive functions are better preserved in patients undergoing local anesthesia. We believe that it would be beneficial to prefer local anesthesia in patients without definitive contraindications.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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